

REMARKS**STATUS OF CLAIMS**

Claims 1-19 are rejected.

Claims 1-19 are pending under consideration.

ITEM 1: REJECTION OF CLAIMS 1-5, 8-11, 13-19 FOR OBVIOUSNESS UNDER 35 U.S.C. §103(a) OVER HORITA ET AL. (U.S. PATENT 6,034,422) IN VIEW OF ADLER (U.S. PATENT 4,997,722);

The rejections are respectfully traversed.

The present invention concerns a conductor substrate, typically a lead frame (claim 8) or a heat-dissipating plate (claim 11), for mounting a semiconductor element and sealed with an insulating resin, and a semiconductor device using the conductor substrate.

As described on page 4, lines 18 to 26 of the specification, an object of the present invention is to provide a conductor substrate which is capable of withstanding stress due to expansion of the insulating resin and also is capable of providing intimate adhesion of the insulating resin to the conductor substrate. That is, the present invention is directed to improving an interfacial strength between a conductor substrate, such as a lead frame, and the insulating resin.

HORITA ET AL. (USP '422)

Horita et al. (USP '422) describes a lead frame for a semiconductor device, and, as the Action notes at page 4, it describes application of copper or an alloy thereof to the conductor substrate and covering of the conductor substrate with a layer of copper oxide. A typical example is illustrated in FIG. 5(d). The problem of USP '422 resides in a deterioration of the interfacial strength between the copper alloy substrate and a copper oxide layer.

ADLER (USP '722)

Adler (USP '722) describes a method for improving adherence of a copper foil to a resinous substrate to provide a strong bond. The copper foil is treated with "black oxide" or is blackended to produce whiskers of copper oxide which contain copper hydroxide. However, since copper hydroxide adversely affects the formation of whiskers, the copper hydroxide is removed by a subsequent reduction step.

NAGAI ET AL. (US '597)

US '597 describes a copper-alloy foil for a laminated sheet of a printed circuit boards. Paragraph 0023 describes that the adherence of the epoxy resin and copper-alloy is enhanced due to the hydrogen bond between the hydroxyl groups of the epoxy resin and the oxygen atoms of the copper-alloy.

THE CLAIMS PATENTABLY DISTINGUISH OVER THE REFERENCES AND REJECTIONS OF ITEM 1

As the Examiner concedes in the Office Action at page 2 of the Action, Horita et al., USP '422 does not teach that the copper oxide layer contains a hydroxide, whereas claim 1 of the application expressly recites a covering layer of copper oxide containing a hydroxide. Thus, the primary reference to Horita et al. (USP '422) is conceded by the Action to lack any teaching of the claim 1 recitation of the conductor substrate being partly or entirely covered "with a layer of copper oxide containing a hydroxide...."

The structure defined by independent claim 1 of the application, moreover, affords a significant improvement in the interfacial strength of the layer of copper oxide containing a hydroxide and the semiconductor substrate, relative to that afforded by Horita et al. (USP '422). More particularly, to prevent delamination of the copper alloy substrate and the copper oxide layer, Horita et al. (USP '422) teaches partial plating, or flashing, a noble metal such as silver, gold, platinum or palladium (e.g., see Horita et al. claim 1: "where...the surface of the copper alloy material at least on a side of said lead frame to be contacted with an encapsulating resin has a thin noble metal plating...."). Particularly, Horita et al. teaches that delamination is caused due to deterioration of the interfacial strength between the copper alloy substrate and the copper oxide layer - - and, as taught by Horita et al., the noble metal is effective to prevent that deterioration because it is diffused into the copper oxide layer, thereby forming a stronger Cu₂O layer, upon application of heat during IC assembly.

Contrary to this teaching of Horita et al. and according to the present invention, the copper oxide layer containing a hydroxide formed upon treatment of the underlying copper lead frame improves the interfacial strength between the copper lead frame and the insulating resin. This method is simple and cost saving.

In the Action at page 2-3, the Examiner attempts to overcome the deficiency of Horita et al. by citing Adler (USP '722) as teaching a copper oxide layer containing a hydroxide formed upon surface treatment of a conductor substrate (col. 6 at line 54-66 and col. 3, line 28-29).

However, as mentioned above, the hydroxide-containing copper oxide layer is reduced in USP '722 to remove the hydroxide component from the layer. (See, col. 3, lines 37-53. See also col. 4, lines 4-11, col. 5, lines 12-26, col. 7, lines 58-61 and col. 8, lines 1-27 which point out the difficulties of achieving the reduction step while still retaining a whiskered surface; see also col. 9, lines 3-9 which concludes the disclosure by pointing out that "the present invention...provides a metallic copper surface, rather than an oxide surface that is reduced by the reducing agent....")

As reinforcement to the foregoing demonstration that Adler (USP '722) has no teaching of a copper oxide layer containing a hydroxide, see also claim 1 wherein no such copper oxide layer containing a hydroxide is recited - - and, instead, consistent with the above statement of the "problems..." overcome by Adler, claim 1 recites:

A layered product comprising at least one copper layer bonded to at least one resinous dielectric layer, wherein each copper layer has at least one whiskered surface, said surface incorporating the metallic copper reaction product of a transient copper oxide layer...."

(Emphasis added).

In accordance with the foregoing, it is submitted that all of the claims rejected in the Item 1 at page 2 of the Action patentably distinguish over Horita et al. and Adler, since all share the patentably distinguishing recitations of independent claim 1 and, furthermore, for the additional patentably distinguishing recitations of the respective dependent claims.

ITEM 2: REJECTION OF CLAIMS 6 AND 7 FOR OBVIOUSNESS UNDER 35 U.S.C. §103(a) OVER HORITA ET AL. AND ADLER IN VIEW OF NAGAI ET AL. (U.S. PATENT 2003/0044597)

Claim 6, from which claim 7 depends, recites further that for the conductor substrate according to claim 1:

said insulating resin is a resin comprising a hydroxyl group in the molecule thereof, and a hydrogen bonding force is generated between said hydroxyl group-containing resin and said layer of hydroxide-containing copper oxide.

In citing forth grounds of rejection in Item 2 with respect to claims 6 and 7, the Examiner states at pages 5-6 of the Action that Nagai et al. (USP '597) teaches "an epoxy resin containing a hydroxyl group, wherein there is a hydrogen bonding force between the resin and a copper oxide...." The Examiner then contends:

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use an epoxy resin in the device of Horita et al. as taught by Nagai et al. in order to improve the adherence between the lead frame and resin.

It is submitted that the Examiner has altogether lost sight of the dependent character of claims 6 and 7 and overlooked the primary features of the invention as defined in claim 1.

It is abundantly clear that Nagai et al. (USP '597) is silent concerning incorporation of hydroxide into the copper oxide layer, and relies, instead, upon formation of an oxide layer of 10 nm (0.01 μm) or less. With regard to the thickness of the copper oxide layer, it should be noted that the thickness of the present invention is 0.02 to 0.2 μm (see claim 13).

Accordingly, inasmuch as all of the dependent claims - - necessarily, including claims 6 and 7 - - inherit the patentably distinguishing recitations and distinctions of claim 1, over the references and rejections of record, it is submitted to be clear that Nagai et al. does not overcome the already established deficiencies of the primary references to Horita et al. and Adler and, accordingly, claims 6 and 7 distinguish over the primary combination taken further in view of Nagai et al., as well.

It is submitted that the Action has failed to identify any teaching in Adler offering any motivation for the combination of that reference with Horita et al. Indeed Adler teaches removing a hydroxide on the surface of a copper oxide layer by reduction while carefully retaining whiskers to improve adhesion. As such, Adler is clearly a "teaching-away" from the present invention.

Nagai et al., on the other hand, is irrelevant to the invention as defined in claim 1 and, it follows, as defined the dependent claims, as well.

LACK OF *PRIMA FACIE* DEMONSTRATION OF OBVIOUSNESS OF THE COMBINATIONS RELIED UPON

It is submitted that the Action fails to satisfy the requirement of a *prima facie* demonstration of obviousness of the combination and, instead, relies on the discredited bare contention that the combination "would have been obvious to one of ordinary skill in the art...." Moreover, motivation to effect the combinations is not supported by the Examiner's suggestions. See MPEP 706.02(j), which emphasizes that the Examiner should set forth in the Office Action: (A) the relevant teachings of the prior art relied upon, preferably with reference to the relevant column or page number(s) and line number(s) where appropriate, (B) the difference or differences in the claim over the applied reference(s), (C) the proposed modification of the applied reference(s) necessary to arrive at the claimed subject matter, and (D) an explanation

why one of ordinary skill in the art at the time the invention was made would have been motivated to make the proposed modification.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). See **MPEP § 2143 - § 2143.03** for decisions pertinent to each of these criteria.

CONCLUSION

It is respectfully submitted that the foregoing demonstrates that the rejected claims 1-19 clearly, patentably distinguish over the art and rejections of record and are in condition for allowance. There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.


If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

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Date: August 22, 2006

By: _____


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